FRANKLIN 400

SERIAL #_____

CALIBRATION _____

AC ZERO READING _____

MODEL 400 - DIGITAL MULTIMETER

403

MP MASTER
MA32591

Model 400 Multimeter Manual

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Specifications

Operation Modes

Calibrate, +DC, -DC, AC Ohms

Calibration is against an internal mercury cell.

D.C. Voltage Measurement

Positive or negative, selected on mode switch.

Ranges: 0 to 10, 100, and 1000 volts, switched manually.

Absolute Accuracy: ±0.3%, 0 to 10 volts scale.
±0.5%, 0 to 100 and 0 to 1000 volts scale.

Comparative Accuracy: ±0.1% all scales.

Input Impedance: 20 megohms

A.C. Voltage Measurement

Ranges: 0 to 10, 100, and 1000 volts RMS, switched manually.

Absolute Accuracy: ±1.0% from 0.5 volts up, at 60 cycle (sine) all scales.

Comparative Accuracy: ±0.1% from 1 volt up, at 60 cycle (sine) all scales.

Frequency Response: Flat within 0.5 db, 50 cps to 100KC.

Input Impedance: 20 megohms shunted by 200 $\mu\mu$f.

A.C. Resolution: .01db of full scale above .5 volt.

Ohms Measurement

Ranges: 0 to 100K, and 1 meg., switched manually.

Absolute Accuracy: ±0.5% on all scales.

Comparative Accuracy: ±0.1% on all scales.

Accuracy with External Standards, ±0.1%

Due to the high "Comparative Accuracy" of the instrument, it can be used to ±0.1% absolute accuracy on any mode or scale if accurate standards are available to calibrate each of the scales.

Long Term Stability - No Calibration or Checking for 24 Hours

For continuous operation conditions like production control, incoming inspection, etc.

Room Temperature Range: ±25°F; over a 24 hour period.

Absolute Long Term Accuracy: DC ±1.5%, AC ±2.0%

ohms ±2.5%.

General

Warm-up: Allow 15 minutes

Internal Temperature Rise: Approximately 25°F.

Dimensions: 11" high x 10-3/4" wide x 15-1/2" deep.

Weight: 26 pounds

Power Requirements: 107 to 123 volts AC 60 cycles
200 watts approximately at 110V
60 cycles

In the above specifications, "Comparative Accuracy" refers to the accuracy with which the instrument will determine the difference between two voltages or two resistances (not more than 10% apart) by measuring one and then the other.

"Absolute Accuracy" refers to the accuracy with which it will measure any voltage or resistance, when manually calibrated by its internal mercury cell standard. Since

the ramp slope and linearity are very precise by repetitive, they will repeat very accurately, and thus make accurate comparisons without regard to absolute accuracy.

All percentage figures are of FULL SCALE. Accuracy figures are given for room temperature (75°F) except where stated otherwise.

Full scale (1) 000 is presented as 000 with the digit 1 understood.

The Digital Multimeter, as shipped from the factory, has had all necessary internal adjustments to meet the specifications described in the previous section. To operate the instrument, carry out the following procedure in whole or in part.

1. Plug in the line cord and turn the RANGE switch to X.01.
2. Turn the MODE switch to ±DC and short the input leads.
3. Adjust the ZERO control to read either 000 or 001, preponderantly 000. (It is completely normal for the instrument to "jitter" two numbers.) When the zero is too low, readings in the 900's will be obtained. This is normal. Turn the zero knob clockwise and zeros will appear.
4. Turn the MODE switch to CAL. Adjust the reading to the value marked on the instrument with the GAIN control. The ever present jitter should be from the number to one digit above it, as at zero. (For example, if 940 is the calibration reading, adjust to 940-941, with 940 appearing preponderantly.) If the CAL reading was considerably off to start with, check zero again and then calibrate again. The Digital Multimeter is now set up to meet all absolute ±DC voltage and ohms accuracy specifications.

Simply turn the range switch to the desired position. As the instrument becomes warm, (15 minutes for complete warm-up), calibration and zero will change somewhat. Rezeroing and recalibrating will restore the starting accuracy.

5. After calibration in paragraph 4 above, -DC, ±DC and ohms will all be accurate to absolute specifications. AC measurements, however, require re-zeroing. Do not zero on AC, then adjust calibration. The calibration will then be in error. Rather, adjust calibration using a DC zero, and then readjust the AC zero as indicated on the front of the instrument.

6. If, instead of using absolute accuracy specifications, it is desired to take advantage of the relative accuracy of the Digital Multimeter to obtain .1% measurements, disregard the self-calibration described in paragraph 4 above and calibrate instead with an external standard of your choice. For accurate results use standards within ±10% on AC volts and ohms and within ±25% on DC volts. Please note that such calibrations apply only to the one particular [illegible] on which you are using the external standard. [illegible] must check to make sure your zero setting is correct before calibrating to external standards.

7. Some consideration must be given to "hum" and noise which may accompany DC and ohms measurements. Some degree of filtering has been done in these modes of operation. More could be done if long time constants were employed, but to filter adequately, (say 10 volts AC superimposed on 10 volts DC) to below 1 count would require time constants in excess of the user's patience as he waits for his answer. The conventional meter movement simply averages out hum. The Digital Multimeter on the other hand uses instantaneous comparators to obtain measurements and hence "sees" the instantaneous values of input voltages. The filtering built into the instrument will remove about 1/4 of the hum at 60 cps; more at higher frequencies. If the user wishes to filter further he can either increase C17 or R36 on the schematic, at the expense of delayed readings, or filter some way externally, bearing in mind the 20 megohm input impedance divider action. Evidence of hum is given by excess "jitter" or non-repeating readings. If the hum is really large, the instrument appears to "run-wild".

8. It is impossible to damage this instrument as long as voltages do not exceed 1000 volts. If, inadvertantly, a wrong polarity voltage is put in, or if an overload is applied, or if AC is applied on an DC mode of operation, etc., the instrument will "run-wild" and quite audible noises will be heard inside. These sensory indications mean nothing. Simply correct the improper mode or range of operation.

9. Chassis is isolated from internal wired grounds. The connector body and probe shield is isolated from chassis by design. The symbol ⏚ on the schematic is internal ground The symbol ⏚ is chassis.

Description of Schematic

A. Schematic 4.30

This schematic includes all circuitry except the counters. These are described in section B.

The basic principal of operation in the Digital Multimeter is to generate a ramp voltage with proper tolerances and to compare it with unknown voltages. The ramp voltage will require a certain time to reach an amplitude equal to the unknown voltage. This time is measured by counting fixed frequency oscillator pulses. The number of counts made is proportional to the unknown voltage.

Low frequency AC, DC, and resistances are measured with a single probe which connects to J1. On all DC ranges, the 20 megohm divider consisting of R81, R4, R5, R82, R6, and R83 is used to normalize all voltages to X.01 range magnitudes. These normalized or attenuated voltages are then passed into the DC amplifier.

On AC ranges, the alternating voltage is normalized first, then passed to an AC amplifier V1. The purpose of the amplifier is to get maximum AC levels <u>before</u> rectifying. (It is true that 100 volt signals could be rectified directly, but then there might be a difference between non-amplified [illegible] full scale signals and 100 or 1000 volt full scale signals.) The following the AC amplifier rectifies the [illegible] The DC signal is filtered by [illegible] and then passed down to the DC amplifier.

...ms ranges, the unknown resistance is made part of a voltage divider ... and. See R1, R2, and R3. R1, R2, and R3 are trimmed by R78, R79, R80, in such a way that full scale unknown resistors of 10K, 100K, and 10 meg all yield the same voltage into the amplifier input and also in such a way that if the voltage across the unknown were proportional to the unknown, (which it isn't), then this fictitious full scale voltage would be identical to the correspondingly correct full scale DC input.

The only other mode is CALIBRATE. In this mode, a mercury battery, calibrated at the factory is measured. This battery (B1) is approximately 9.40 volts. The third place is definitely established on the calibration tag. Note that on CAL, the same situation exists internally as if a measurement were being made on X.01 ±DC. It follows that this range is accurate to .1%, not 3%, if the battery is steady, and the ramp is linear. Franklin Electronics' experience is that this battery has negligible voltage change with temperature at normal operating temperatures. Since the battery is never loaded even during calibration, its life is identical with shelf life. Linearity ... other hand is about .1% off, which is why a ... pec is used on this range.

... have shown how a variety of input measure- ... duced to a common measurement at the DC ... differ ...

The DC amplifier consists of V7, V8 and V9A. Signals described above are first filtered by R56, and C17 before being applied to the input grid. The action of the entire amplifier is such that the two grids of V7 tend to remain equal. Thus if there is a 10 volt change at V7-2, a similar voltage change will tend to appear at V7-7 because of feedback action. The zero adjust, R37, adjusts initial unbalance in the two triodes and at the same time takes up other zero tolerances in the instrument. Since the grids tend to stay together, the voltage across R48 and the gain pot (R71) tends to match the input voltage. But this voltage can come only from the plate of V9A. V9A-1 must travel approximately 10 times as far as V7-2 to keep the V7 grids balanced because of R47 dividing the V9A swing.

R71 controls how far V9A must travel to keep the V7 grids balanced. The voltage gain of the amplifier is thus seen to be the reciprocal of the dividing action of R47, R48 and R71. The output of the amplifier, V9-1 is run to the comparator (CR3 and V11) via R49. The other side of the diode CR3 is driven by the ramp generator.

V9B is a free running blocking oscillator synchronized to line frequency by the filament voltage. Periodically, about twice per second as determined by R58 and C26, a fast pulse appears across R56. The pulse triggers a delay circuit V12. This is a one-shot multivibrator.

Description of Operation

Before the trigger from V9B comes along, V12-6 is down the plate conducting. V12-1 is cut off by the grid cathode relation on the first triode. The trigger, which is negative, cuts off the second triode. This action permits the first triode to conduct. Once the first triode conducts, it is not longer necessary to have a trigger since the first triode will hold off the second triode until the grid of the second triode recovers via C29 and R63. The overall result is a [illegible]tive going "gate" at V12-6 for each V9B trigger introduced. The gate goes negative again when V12-7 recovers. The positive edge of the gate is differentiated and level shifted by C30, R65 and R66. The result is passed through [illegible]

The delayed negative-going part of the waveform is differentiated via C27 and R39 and forms a trigger which operates the ramp gate, V5. This circuit is also a one shot multivibrator. The negative going gate at V5-1 turns on the ramp by cutting off V5A. The positive going gate at V5-6 turns on oscillator pulses into the counters. The ramp gate never resumes its original state on its own. A pulse from the comparator V11 turns it off, terminating simultaneously the ramp and the counting.

The oscillator and pulse generator V6 consist of a crystal controlled 90KC oscillator operating continuously [illegible]

When the suppressor is up, a fraction of the current bursts is diverted from screen to plate. The current pulses times the plate impedance give negative going voltage pulses which drive the counters. Thus, the counters operate only when the suppressor is "up". The suppressor is controlled by the ramp gate (V5) described previously.

When the ramp gate cuts off V3A, the voltage at V3A-1 starts toward +300 volts. However, C6 has to be charged up +300 and this cannot happen quickly with the obstruction of R19. To be specific, the voltage starts out with a slope $\frac{+300}{(R19)(C6)}$ volts/second. Now if only R19 and C6 were involved this rate of voltage rise would gradually slow down as it got closer and closer to +300. But if as fast as the condenser voltage rises, we arrange to have the top of R19 rise equally, the condenser C6 will "think" it is always charging to +300 and hence the rate of voltage rise will be constant. Another way of saying this is that the voltage rise will be linear. V4 and V3B comprise an amplifier with a gain very close to 1. This is used to generate the same voltage as appears on C6 and drive the top of R19.

Once the top of R19 starts to move up V2 cuts off. The ramp output is taken from V3-8 rather than C6 for practical reasons. It will be noticed that in ohms measurements, the feedback to the top of R19 is taken from a different point, namely a tap on R24. In measuring ohms, you will recall that the unknown resistance being measured does <u>not</u> give a proportional voltage, that is, there is a non-linear relationship between the <u>voltage</u>

across the unknown resistor and the unknown resistor. This non-linearity can be accurately predicted and the ramp voltage is deliberately non-linearized slightly to compensate this effect. The ramp is arranged to start always from below ground.

The ramp output is fed to the comparator diode CR3. The other side of the diode has the unknown voltage. V11 is a blocking oscillator with a broken feedback loop. The break is made by CR3. However, when the ramp reaches the unknown level, the diode conducts. The oscillator feedback is therefore closed and a sharp pulse across R38 results. This pulse turns on the ramp gate via V10B. Since the ramp gate then causes the ramp to disappear rapidly, CR3 opens and the comparator is deactivated until the next ramp.

The +300 supply is a completely conventional series regulated supply. Any change in +300 is fed back via R75 and R76 to the grid of V20. The change is amplified by V20 to the grids of V16 and V17 in such a way that the original change in +300 is very nearly compensated by an opposite change. V21 is a voltage reference which conserves loop gain, thus making B+ that much more stable.

The -300 supply uses ordinary gas tube regulation, V18 and V19.

B. Counters (Schematic 3210)

The decade counters in the Digital Multimeter consist of one two-state device, (flip-flop), and one five state ring. The counter as a whole has therefore 5 x 2 = 10 stable states in all. The right hand counter is driven by the oscillator, the middle counter by the right counter and the left by the middle counter.

Each counter will continuously cycle through the ten stable states as long as pulses are fed in.

The input pulses to each counter are fed to the flip-flop (V1) via diodes SR1 and SR2. If V1-1 is "up", then SR2 accepts the pulse. If V1-2 is "up", SR1 accepts the pulse. A pulse appearing at either "up" plate tends to cut off the triode with a "down" plate via C1 or C2 to the grids. Once the pulse has accomplished the switching, opposite plates have permanently changed states until the next pulse comes along. This is a typical flip-flop. It will be noted that on every other pulse V1-2 goes positive. This positive edge is coupled to the cathode follower V2A via C3.

All the cathodes of the ring are tied together. Plate to grid connections are such that when any one of the five triodes, V2B thru V4B, is conducting the other four are non-conducting. There is one speedup condenser from each plate to the next ring in the grid. Thus, if a positive signal at the cathode tends

to turn a conducting tube off, the next tube in the ring is very strongly favored to conduct because of the speed-up. V2A is used to connect the advance pulses from the flip-flop V1 into the ring cathodes. Voltage levels at the flip-flop plates and the ring plates are such that only when a flip-flop plate is "up" and a ring plate "down" can a neon number indicator be lit. Both up or both down will not give a sufficiently large voltage difference to fire a bulb.

Whenever a new ramp is generated, it is necessary to erase the previous count and start counting over again. This process is known as resetting.

One would think casually that the reset should be to zero. In this instrument this is not the case. Reset is to 8 or 888 for all three counters. The reason is that the ramp starts 11.2 volts below ground and the counting starts as soon as the ramp starts. Thus we must reset 112 counts low and count up to "zero". (888 + 112 = 000 if the carry of 1 in the fourth place is dropped).

The flip-flop is reset via SR3 into V1-6. This sets up the "even" neon bus. The ring is reset via SR4, which sets up the (8 or 9) ring triode. Since the flip-flop sets up only the even bus the eight will light.

Maintenance and Trouble Shooting

In trouble shooting the Digital Multimeter two types of failure must be considered:

(A) Failure to read anything or completely "wild" running around. In short, catastrophic failure.

(B) Functional errors such as non-linearity, false calibration, out of tolerance between ranges, etc. These are more difficult to analyze and fix.

Counters

1. Skipping certain numbers for no obvious reason is due probably to faulty voltage levels on the ring grids. Check all "off" ring grids as per the schematic. Deviations of more than eight volts spell trouble.
2. Failure to count past a certain digit is caused probably by excessive ring voltage variations.
3. If the whole multimeter stops, the counters can be roughly checked by disconnecting the oscillator input. If eight's only appear, the counters are resetting properly. If the oscillator is again connected and the oscillator suppressor shorted to ground, all numbers should appear to be lit at once. If this is so, the counters are probably satisfactory and trouble exists in the [illegible]. To eliminate the possibility that the oscillator may not be working, look

at the oscillator pulse input with a scope when the suppressor is grounded. Pulses at least 50 volts negative at 90KC should be observed.

4. Occasionally two neon bulbs on one counter may light. By careful input voltage variations, it can be determined which neon bulb lights when it should not. Replace this neon bulb with one having a higher firing potential. If several bulbs in one counter act that way voltage levels are probably off.

Oscillator

When the suppressor grid of the oscillator tube is grounded, pulses at least fifty volts in amplitude at 90KC should appear at the oscillator plate. If low, tune the oscillator. If not present at all, wave the scope lead in the general vicinity. A large amount of 90KC should be picked up. It is not recommended that a scope be put on the screen since oscillations may then stop due to capacity detuning.

It is generally best not to tune the plate pulses to full amplitude since at maximum output the oscillator is close to quitting. Back off peak tuning somewhat. The range of tuning over which the oscillator continues to function should be quite broad. If not, the oscillator tube is near the end of its life.

If, when the suppressor grid is ungrounded and no 90KC pulses "flash" through at the oscillator plate when the instrument is supposed to be working, then the trouble

is not in the oscillator if all the above tests have been passed.

Triggering

If the Digital Multimeter is triggering itself properly, faint "clicks" should be heard within the unit. This is the blocking oscillator. It is impossible to tell by sound whether both blocking oscillators are working. However, one can be sure that V9B is functioning by the sound alone. If no clicks are heard the difficulty lies in the circuits around V9B.

Delay Gate and Reset

A gate of approximately 1.5 milli-seconds duration should be observed at V12-6 if the clicks can be heard above. If not, V12 or associated circuitry is at fault. This waveform should go positive only when the trigger hits it. This can be ascertained by triggering the scope with the same trigger. If it has already been found that the counters reset properly, this test is not really necessary. Voltage levels are shown on the schematic to assist in locating troubles in this circuit.

Ramp Gate

This gate should be triggered by the back edge of the delay gate described above. A synchronized scope is required to determine this. Voltages are shown on the schematic to assist in trouble shooting. This gate should not exceed .13 milliseconds for a full scale input.

If it does, the comparator is not working or its output pulse is ineffective. This is seen on the counters as a heavy overcount even when the count should be near zero. Overcounts can be identified if all numbers "flash thru" and yet the count indicates a number lower than full scale.

Ramp

If there is a ramp gate there should be a ramp. The ramp should appear linear to the eye on a good linear scope. An obvious non-linearity is a sign that something is seriously wrong. However, if it appears linear to the eye there is still no guarantee that it is sufficiently linear. For these tests use a full scale input. On ohms a slight difference from DC linearity will be observed. Anything appearing worse than 5% non linear is not correct. Schematic voltages will assist in trouble shooting. However, non-linearities are best found by discovering what components in the ramp generator have failed or shifted out of tolerance.

Amplifier

With the input terminals shorted, the zero control should adjust the output at least ± 2 volts around zero. With the calibration input (B_1) the gain control should vary the output at least ± 2 volts around 94.0 volts. Ripple out of the amplifier on any mode or range should be under .1 volts. The amplifier should be capable of

at least 120 volts output. The above data and schematic voltages are the only guides to trouble shooting the amplifier.

Power Supply

+300 ripple must be under .3 volts pp. -300 ripple should be around 1 volt pp with a disturbance every time a reading is triggered. This disturbance is not important if recovery is made before the next reading.

AC Amplifier

The amplifier has a gain of approximately four. From 50 cycles to 100KC there should be no visible distortion of the input all the way to the cathode follower which drives the rectifier. This applies to output levels up to 125 volts peak to peak.

General

If there is catastrophic failure search for unlit tubes or unusually glowing tubes. Check for obvious burn-outs to failures. Check voltage on the schematics. These voltages may differ by tube and component tolerances. If no further off than this, they are o.k. If this gives no hint of trouble listen for "clicks". If heard, start by checking these circuits in the following order:

(A) Power Supply

(B) Input circuitry

(C) Ramp gate

(D) Ramp

(E) Amplifier

(F) Oscillator

(G) Counters

(H) Delay gate

A table of waveforms, Figure 1, is given to clarify the timing sequences.

If there are purely functional troubles, the following check list will be helpful.

DC Linearity

Check amplifier linearity. For example, doubling an input voltage should double the output voltage if the output was zeroed with zero input.

Check the ramp per previous instructions.

AC Zero Very Far Off Proper Value

Check hum out of the AC amplifier with a zero input.

AC Linearity

Check AC amplifier as per previous instructions.

Absolute Accuracy, DC, Between Ranges

Check input divider and amplifier. Input divider has more than likely shifted and needs to be retrimmed.

Absolute Accuracy, AC

If AC amplifier has been checked and DC absolute accuracy is satisfactory, simply adjust AC gain.

Ohms Linearity

Ohms Absolute Accuracy

For both of the above see paragraphs on set-up.

Maintenance and Trouble Shooting

It is good practice to periodically check any meter with good standards. In the case of the Multimeter, the use of external standards vitiates the need for restandardization. However, if overall absolute accuracies are to be maintained against self calibration the following procedures should be carried out every few months.

1. Check the battery voltage B1 to within .01 volt. If no devices are available to do this it is unlikely that any harm will come if this step is skipped.
2. Zero and calibrate to the battery.
3. Obtain one other voltage between 0 and 5 volts known to .01 volts. This voltage should read accurately to within .02 volts on the X.01 scale. If so, DC measurements are linear.
4. Switch to X.1. Obtain a voltage near 100 volts known to within .1 volt. If the resultant reading is not within ±.5 volts adjust R82 to obtain such a reading.

Caution:

Adjust R82 with the cover on and well warmed up.

5. Switch to X1. Obtain a voltage near 1000 volts known to within 1 volt. If the resultant reading is not within ±5 volts adjust R83. Observe the warmup precaution.

6. Switch the AC to any range for which a good low frequency standard is handy. Adjust the full scale reading with R9 on the left printed board. Adjust a 20% full scale reading with the zero control on the front of the instrument. Repeat full scale and 20% scale adjustments until they are no longer required. Then short the input leads to obtain the new AC zero. For high frequency adjustments set up a near full scale reading at 50-100 cycles on the X.01 range. With the same amplitude input at 100KC, adjust C48 on the left printed board to obtain the same reading on the Multimeter. After this adjust the X.1 scale for flat response with C41 and the X1 scale with C42. The latter adjustments are mounted on S2 right behind the front panel. Be sure that calibration is maintained throughout this set-up.

7. Switch to ohms. R x 10 which is 10K full scale. Adjust R78 (third pot. from the top, right front) to about the middle of its range. Using the 9K test point, adjust R24 (hole, left rear) so that the count is exactly 900. Transfer to the test point 90K

and adjust R79 (second pot from the top, right front) to read exactly 900. Transfer to the 900K test point and adjust R80 (first pot. top right front) to read exactly 900. Maintain careful voltage calibration throughout these adjustments.

In general, R24 will adjust all three ranges simultaneously. Thus, if all three ranges are equally off only R24 need be trimmed. Relative differences between ranges are trimmed by R78, R79 and R80. With the test points available on the front panel the adjustments can be made in a minute or so, and therefore is easy to do "on line".

Waveforms

The following idealized waveforms will appear at the various points designated on the drawings. Pulse amplitudes may vary ±10% without affecting the overall performance of the instrument.

Scope Set-up

1. Use external trigger input to observe all waveforms. The trigger can be obtained from pin #2 of T2, or V11 pin #5.
2. Ground - The most convenient place to connect to ground is the oscillator tuning slug screw which is located at the upper left hand corner of the right circuit board (when looking at the instrument "head on").

Maintenance and Trouble Shooting

The following sequence should be used to check out the operation of each stage in the Multimeter.

Trigger Generator

Proper operation of the trigger generator can easily be checked by comparing the waveform at T2, Pin #5 with Figure #1 of the drawings. The negative going trigger pulse is transferred to the plate of the "one shot multivibrator" V12 through C28. V12 in turn generates a square wave 1.2 ms wide (Figure #2).

Delayed Trigger

Observe the waveforms at Pin #1 (Figure #2) and Pin #6 (Figure #3). The pulses at the plates of V12 are identical except for polarity.

Reset Gate

The leading edge of the pulse output of V12 (Pin #6) is differentiated by C30 and R66 and is used to reset the decade counters via cathode follower V13A. (Figure #4) Pin 2 of V13, Figure #5 (RB 9).

Ramp Gate

The delayed trailing edge of the pulse from V12 (Pin #6), is diode coupled to the plate of V5 the ramp gate generator (see Figure #6A and 6B).

The width of the ramp gate is controlled by the output of V11 the voltage comparator (see Figure #7).

The negative going gate from V5, Pin #1, is directly coupled to the grid of V3A (Pin #2) and controls the ramp generator on-off time.

Ramp Generator

To check this section observe the waveforms of V3 and V4 (Figures #8 and #9).

The ramp should appear to be perfectly straight if viewed on a good linear scope.

The ramp should also appear on terminals #1 and #4 of the pulse transformer T1 and on the plate side of the comparator diode CR3.

Oscillator Gate

The ramp gate tube V6 simultaneously performs two functions:

1. Permits the ramp generator to function.
2. Turns on the crystal oscillator by effectively grounding the suppressor, thus allowing oscillator pulses to enter the decade counters.

The oscillator gate can be seen at V5, Pin #6 and V6, Pin #7 (Figures #13A and 13B).

Oscillator and Pulse Generator

V6 is conventional crystal oscillator that is turned on and off by the ramp gate applied to the suppressor grid.

*Check initial crystal operation by observing the continuous oscillations at the screen grid of V6, Pin #6 (Figure #14). Next the gated output should be observed on Pin #5 of V6 and at R38 (Figures #15A and 15B).

Comparator

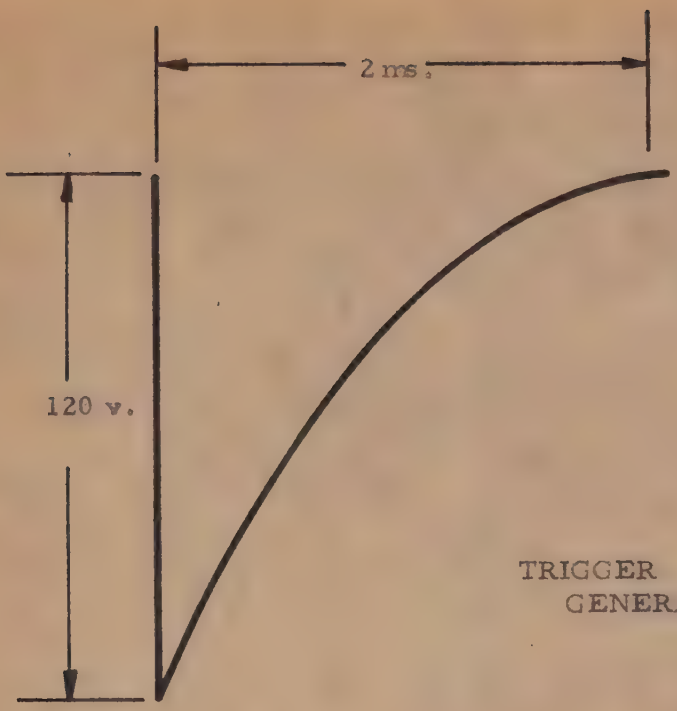
The rising ramp voltage is compared to the unknown voltage at CR3. The instant coincidence is reached the comparator fires and fast pulses appear at Pin #1 and Pin #5 of V11. (See Figure #10 and Figure #11:)

The comparator output is diode coupled to the ramp gate through V10B (Figure #12) and causes the gate to suddenly cut off the ramp and turn off the crystal oscillations. In essence, the counting operation is completed.

*Do not connect the scope directly to the screen merely hold it close and turn the vertical gain of the scope up to maximum.

Warranty

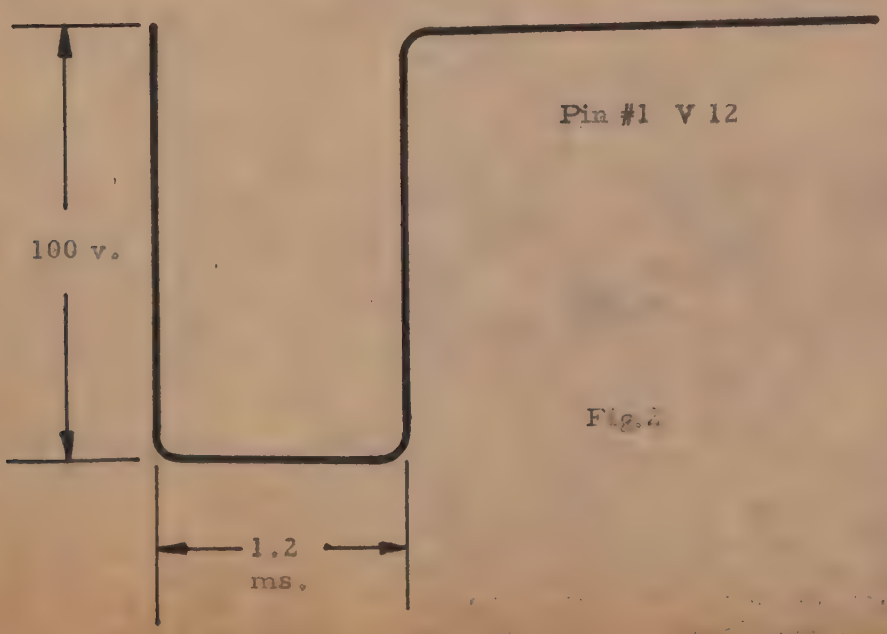
All Franklin products are manufactured of quality materials and are carefully inspected before being shipped from the factory. Franklin's products are warranteed to be free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment from our factory (with the exception of vacuum tubes and batteries). Within that time we shall repair or replace, F.O.B. our factory, any of said products which are returned to us with shipping charges prepaid and which, upon our examination, are disclosed to be defective.



T 2 #5

TRIGGER
GENERATOR

Fig.1



Pin #1 V 12

Fig.2

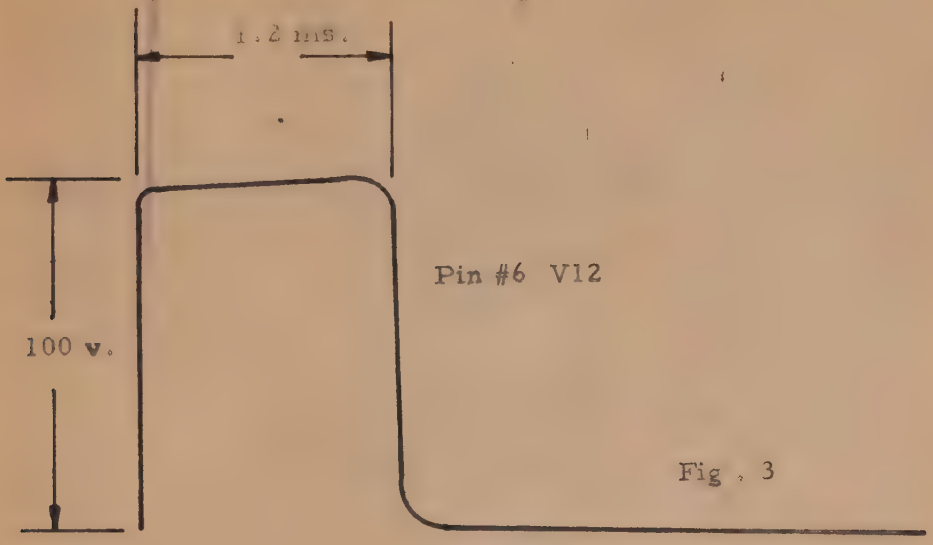


Fig. 3

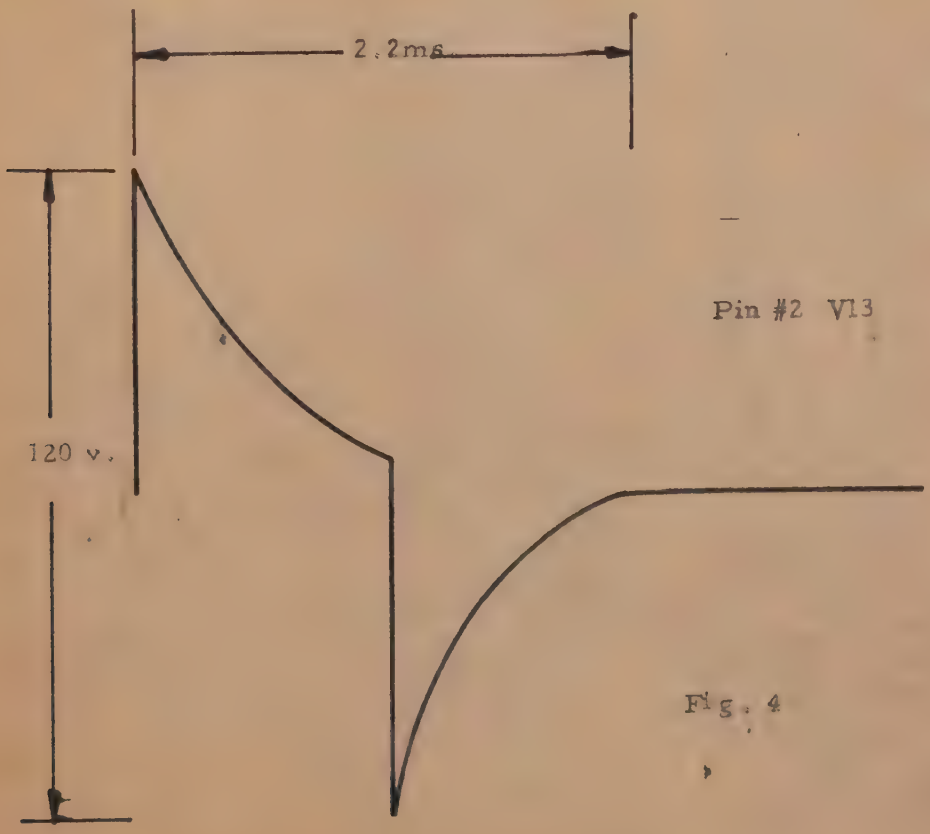
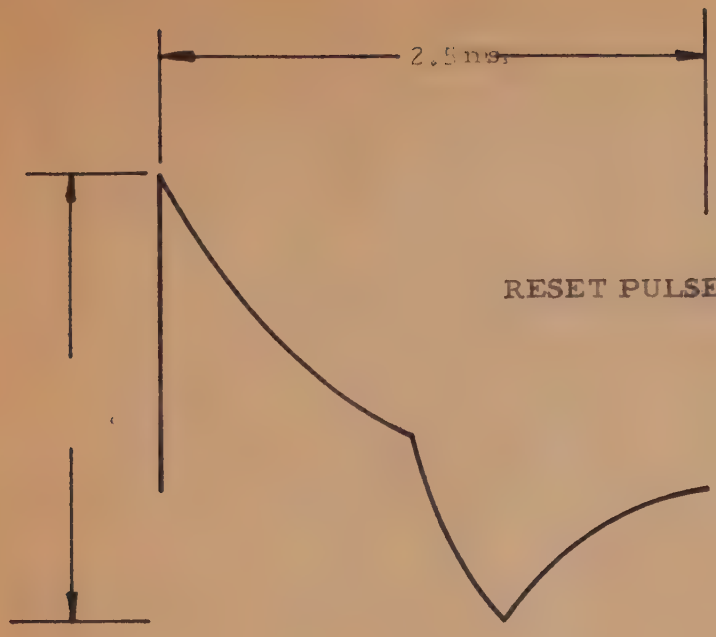


Fig. 4

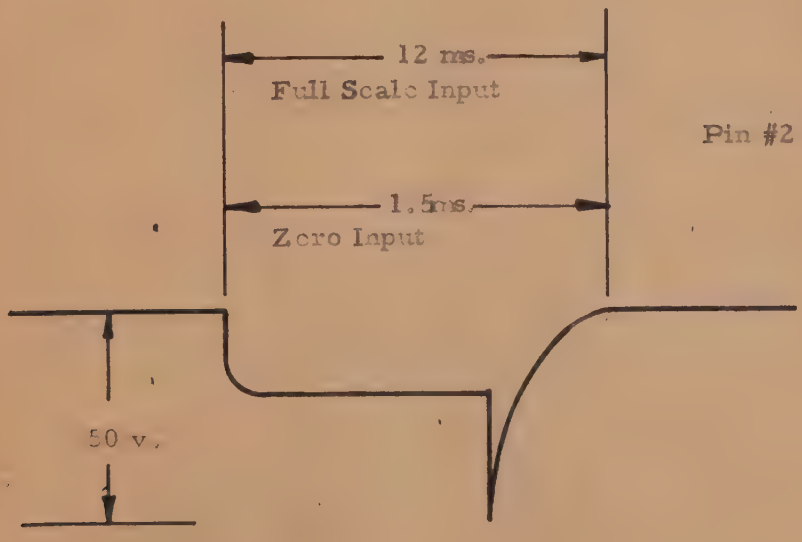


RESET PULSE

Pin #3 V13

RB 9 (On Circuit Board)

Fig. 5



Pin #2 V5

Fig. 7

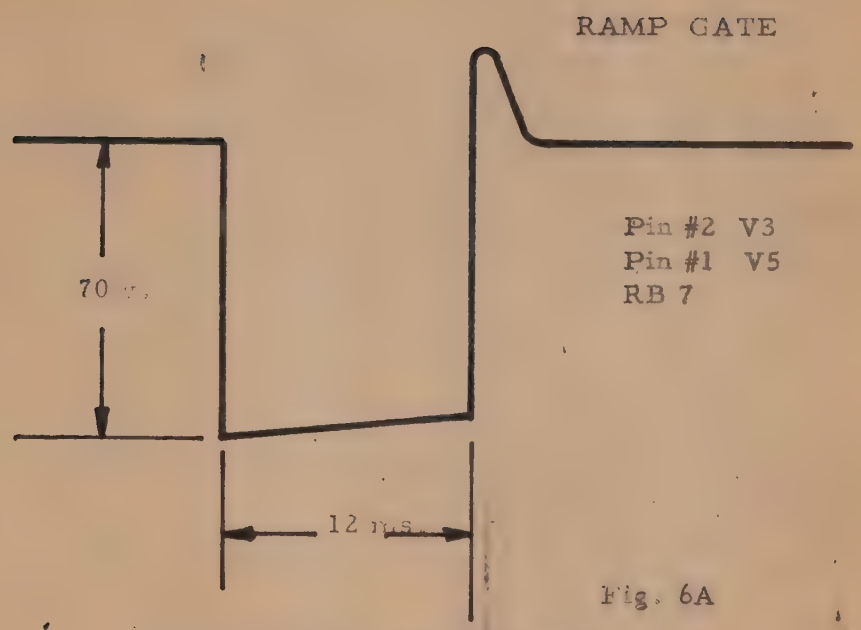


Fig. 6A

GATE Width at Full Scale Input

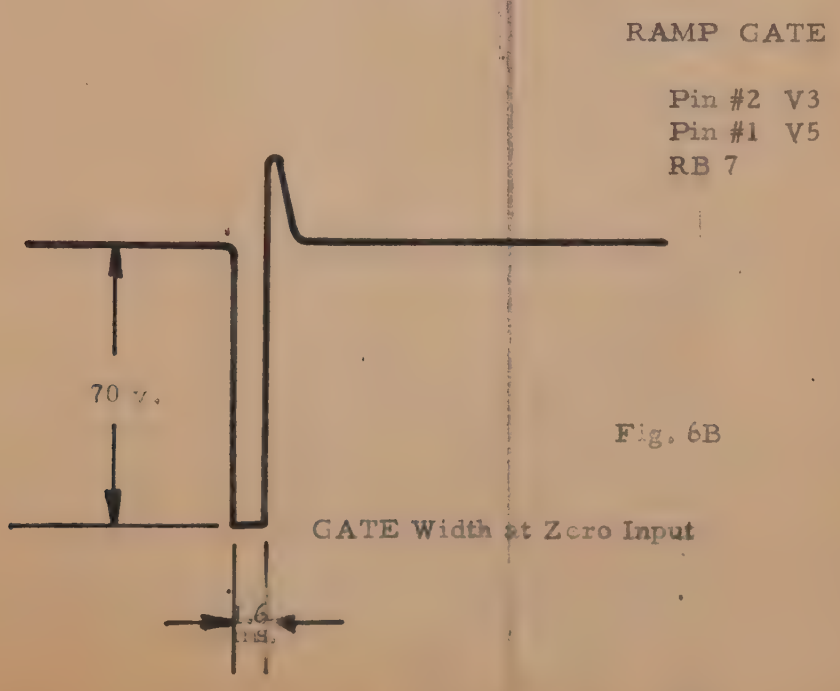
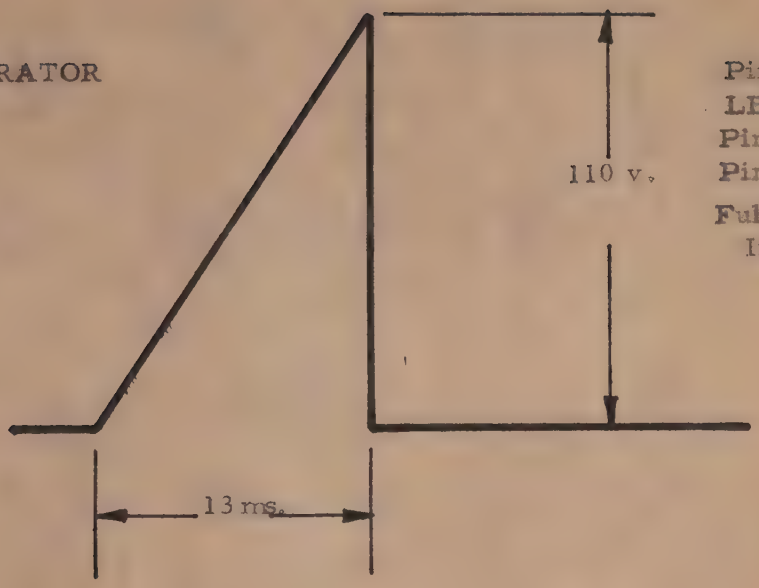


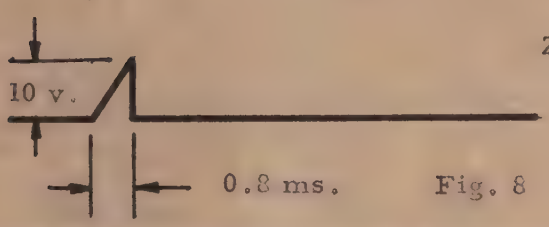
Fig. 6B

GATE Width at Zero Input

RAMP GENERATOR
OUTPUT

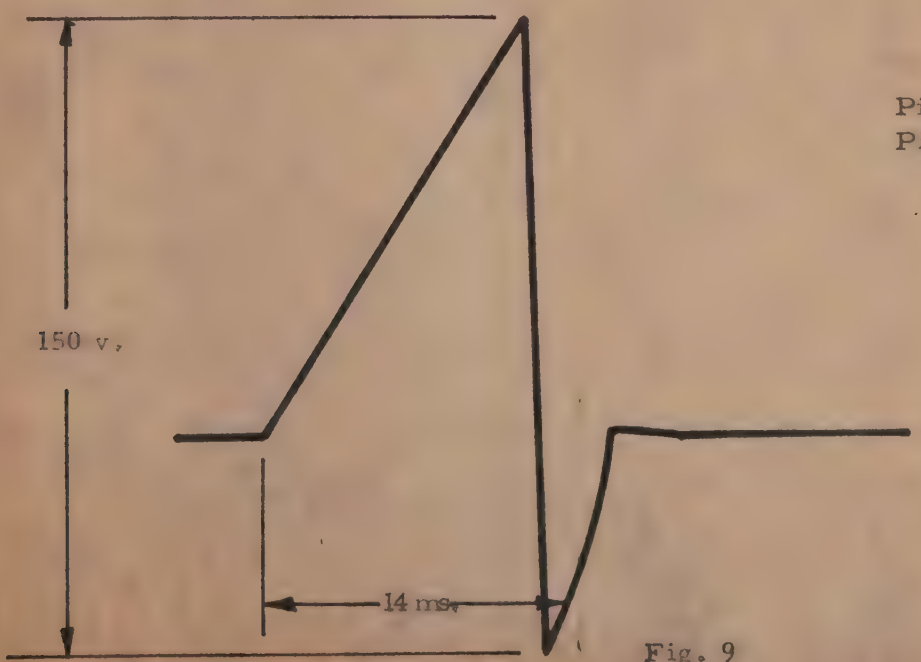


Pin #8 V3,
LB 5
Pin #2, #7, V4
Pin #1, V2, V3
Full Scale
Input



Zero Input

Fig. 8



Pin #7, V3
Pin #6, V4

Fig. 9

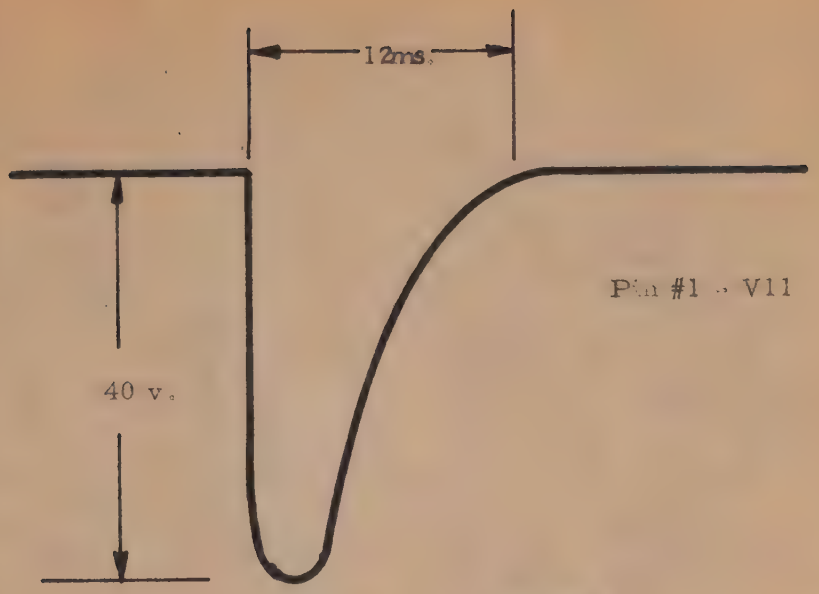


Fig. 10

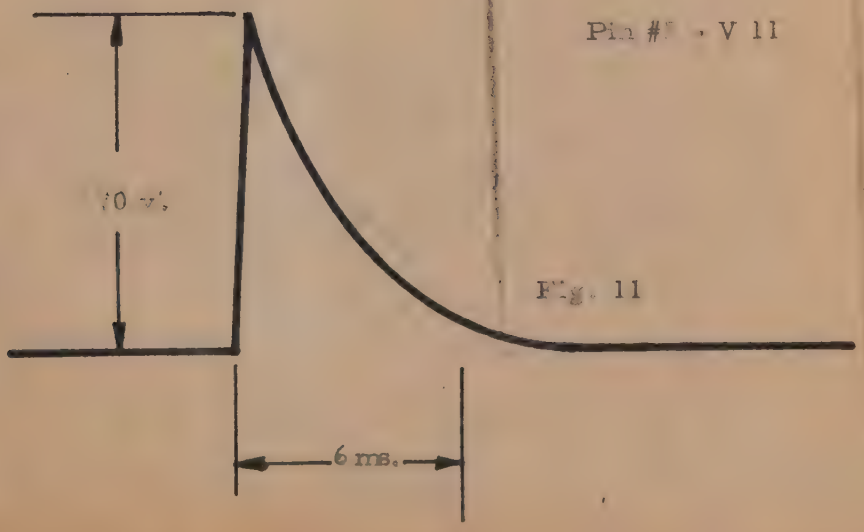


Fig. 11

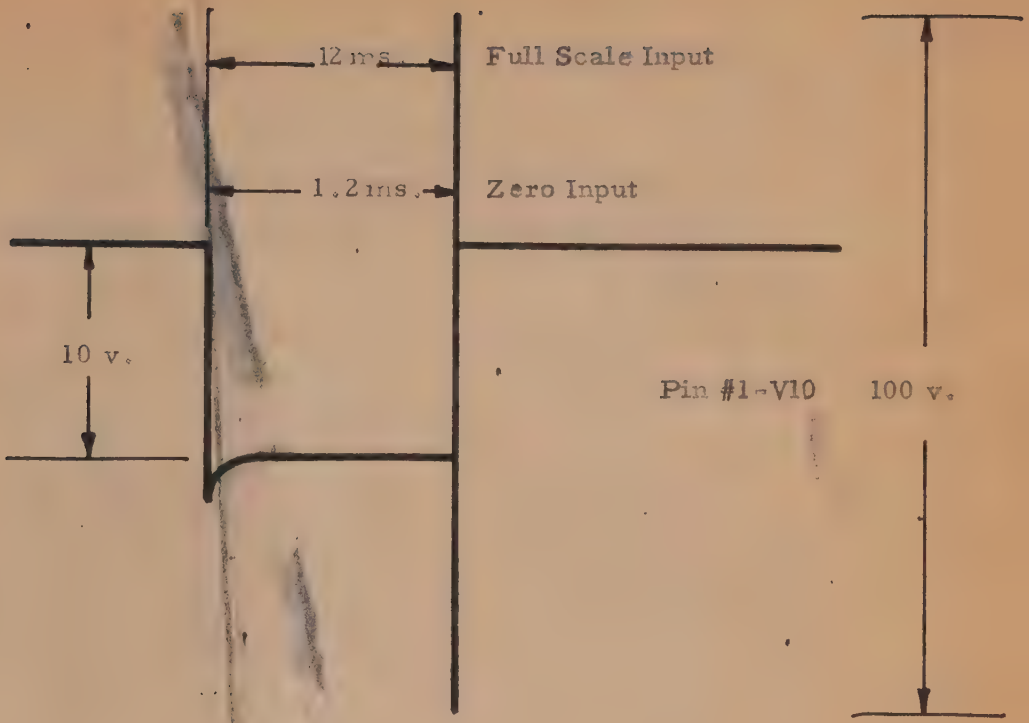

12 ms.
Full Scale Input
1.2 ms.
Zero Input
10 v.
Pin #1-V10
100 v.

Fig. 12

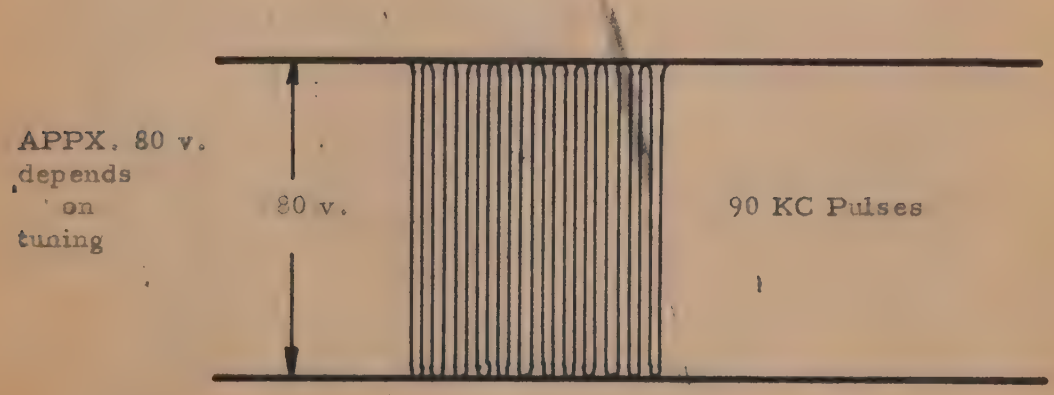

APPX. 80 v.
depends
on
tuning
80 v.
90 KC Pulses

Fig. 14

OSCILLATOR GATE

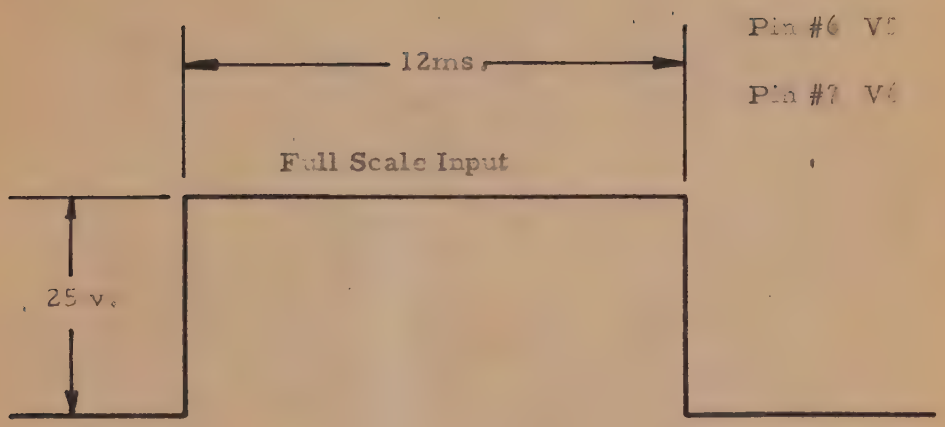


Fig. 13 A

OSCILLATOR GATE

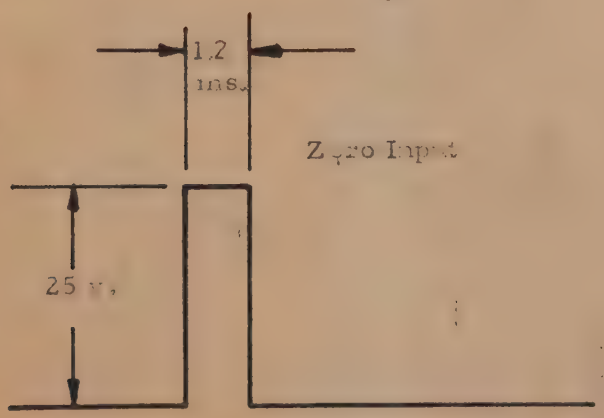
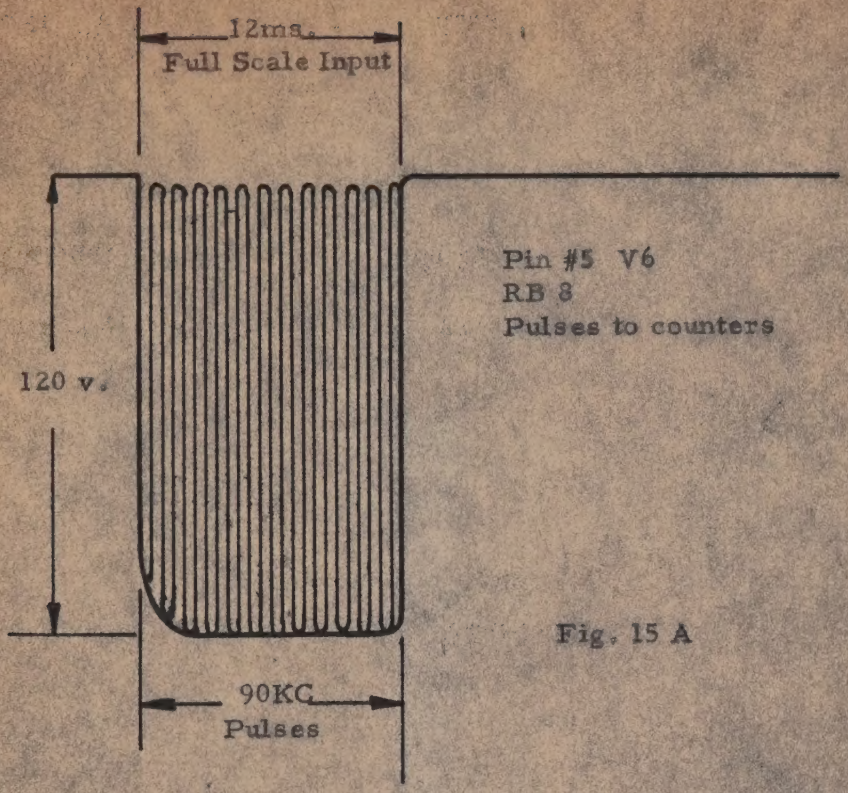
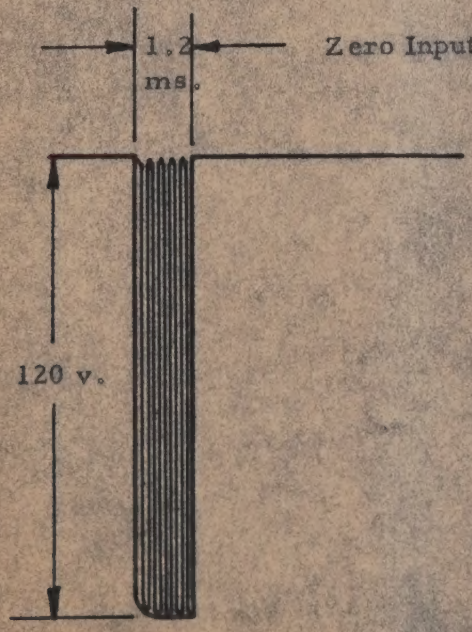


Fig. 13 B



Pin #5 V6
RB 8
Pulses to counters

Fig. 15 A



Pin #5 V 6
RB 8

Fig. 15 B

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